Summary of Major Points Discussed at Carrier
Coordination Meeting Sponsored By The
Rural Electrification Administration
Held at Washington, D. C.
April 14, 1954

This summary covers comments made and subjects discussed during the course of the meeting primarily in the order of their occurrence. (A general discussion by all attending the meeting was encouraged.) Hence the summary does not diligently follow the prepared outline which was used as a basis for discussion.

I. Opening Discussion

The purpose of the meeting was to define fully the factors involved in coordination rather than an immediate attainment of a solution.

A typical REA-financed telephone system was briefly described. It is in an area with low subscriber density. Complete rehabilitation of existing plant is often required. Carrier systems of various types are being considered as a means for reducing costs. Present rate of loan program is $75 million per year and 40,000 miles of construction per year.

Carrier equipment terminal costs seem to have been reduced in greater proportion than convential telephone plant in recent years and great expansion of carrier systems of all types is anticipated in the next five years.

There is a possibility that it may be extremely difficult to utilize carrier systems of all types to their utmost in telephone plant (despite low equipment costs) because of coordination problems.

Power companies, railroads, etc., also use carrier equipment but the attention of this meeting was confined to telephone facilities. Power line carrier manufacturers were represented at this meeting, however, since REA will probably employ this type of carrier for both trunk and subscriber line service in certain remote areas.

REA will not sponsor any movement toward restrictive agreements pertaining to carrier system coordination. It is necessary to maintain flexibility to obtain maximum utilization and an open-minded approach toward new designs.

Principles of coordination

1. Design and apply equipment so as to have minimum interfering effect on other systems.

2. Design and apply equipment so as to minimize susceptibility to interference.

3. Work out over-all engineering solution which is least expensive where problems occur.

II. Frequency Coordination

Frequency stability of various carrier systems on the same pole leads should be such as to prevent harmful effects to toll or subscriber line carrier systems operating on the same pole leads. The question was asked as to what degree of frequency drift would be permitted subscriber line carrier systems.

Subscriber line carrier systems should not be allowed to degrade toll trunks since the blame would not be confined to local loops.

Toll call satisfaction is becoming more tightly controlled by tributary trunks and subscriber loops. One of the toughest transmission problems is that of subscriber loops.

Farmers are just as important customers are are city dwellers.

End lines should be no worse than the rest of the over-all connection.

One manufacturer said that he plans to maintain the same standards on subscriber line carrier systems as are used on trunk carrier systems.

A question was raised as to the possibility of universal coordination.

Mention was made to the effect that the entire carrier frequency spectrum is now in use....Since frequency conflicts already exist, the question was raised as to the extent of the present conflict of frequencies... A new allocation of frequencies was suggested for subscriber line carrier systems and small tributary trunk groups similar to those found in REA-financed systems. It was also suggested that consideration be given to the amount of usage of various carrier frequencies by manufacturers in any frequency allocation scheme.

One survey of independent telephone systems revealed that approximately fifty percent of the subscriber line carrier circuits will eventually appear on the same pole leads as those used for toll carrier circuits. Due to this factor, the coordination with toll carriers cannot be ignored.

The carrier frequency and level information prepared by REA was discussed. REA would like each manufacturer to review the information pertaining to his equipment and correct any errors that might be present. In addition suggestions for modification and supplementary information are requested.

Both Stromberg-Carlson Company (SETCO) and the North Electric Manufacturing Company indicated that they are changing some of the carrier frequencies listed in the data supplied by REA.

It was mentioned that the upper frequency regions of carrier systems are infrequently involved in coordination problems.

It was stated that historically outside plant was not built with the prospect of carrier usage in mind. It was necessary to surmount this problem in the past. The suggestion of a new frequency allocation for subscriber line carrier systems and small tributary trunks made previously was endorsed.

III. Level Control

Frequencies should be selected to give optimum coordination based on present usage. Since it is impossible to select frequencies which will not be in conflict under some circumstances, the following factors should be considered:

1. Levels

2. Coupling between disturbing and disturbed circuits.

3. Susceptibility of the disturbed system. Weigh simplicity of fixed levels vs. increasing coupling control. Level adjustment looks most economical.

When systems are not coterminous, coordination is more difficult. Short systems of relatively high level can introduce crosstalk into an adjacent system of longer length.

The control of carrier system levels can pay big dividends in system performance. It was suggested that provisions be made to limit levels in various carrier systems.

It was mentioned that level control need not be of any vernier type and that a control for providing sizable steps in the level might be satisfactory. Various means for setting levels were briefly discussed and the question was asked as to what type of test equipment is usually found in small telephone systems.

Necessity for exchange of level information on carrier installations between various telephone companies exists. Merely adjusting the level of one carrier system does not assure that both systems are coordinated. Even a third carrier system might be affected, particularly at the higher carrier frequencies.

The fact was pointed out that smaller midwestern telephone companies not employing transmission engineers utilize the transmission engineering staff of the larger companies as a means of solving mutual problems. A high level of cooperation is achieved under this arrangement.

It was further suggested that the various carrier manufacturers interchange information on equipment levels....If manufacturers coordinate their equipment designs, it will make it possible for the user to coordinate his system with others much more effectively.

IV. Receiver Sensitivity, Selectivity and Impedance Considerations

Effects on carrier operation when receivers with high sensitivity are used was discussed briefly.

The definition of selectivity on an FM system is different from that of an AM system.

It is the responsibility of the carrier equipment manufacturer to furnish realistic characteristics concerning his equipment to users for proper application.

Impedance matching is desirable to avoid reflected nearend crosstalk.

The advantage of compandors with respect to reflected nearend crosstalk was brought out. The usage permits less severe limitations on impedance variations....Difficulties of designing transposition schemes for various line and terminal impedances were mentioned.

Carrier systems generally cannot be constructed to the order of knowledge of the average small telephone company. Installation and operation both require technical know-how.

Refinements in carrier systems usually are requested by users as they become more educated to carrier system operation. Manufacturers should train the people who purchase carrier equipment from them.

The trend in telephone business is that companies are becoming more adept at operating and servicing more complex carrier systems.

Balance to Ground

A question was raised as to how balance to ground is measured and within what limits will the equipment be considered as having been balanced.... Metallic voltage reading (from line to line) should be 40 db lower than voltage between lines and ground....It was then suggested that micro-amperes per volt be used in expressions of equipment balance to ground... It was further suggested that figures on this measurement be incorporated in the summary of the meeting.

Various methods for measuring equipment balance to ground were discussed.

Methods of measurement similar to that given below are commonly employed.

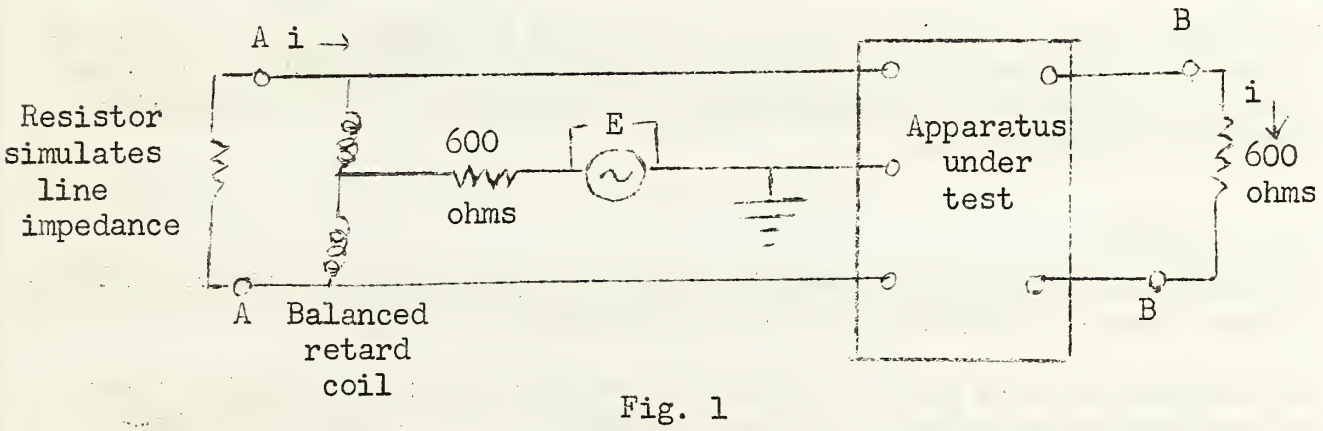

Fig. 1

Line Unbalance can be expressed in microamperes per volt (i/E) for voice or carrier frequencies.

A Western Electric Company 2B Noise Meter or equivalent can be connected to either terminals A or B of Figure 1.

Some average Measured Cable Unbalnces (i/E) at carrier frequencies are given in the following table:

Kc	26-pair Plastic	51-pair Plastic	Quadded Toll-Paper Short Pair Twist	909 Pairs Paper
18	33	29	-	-
40	-	-	9	35
122	35	31	-	-
150	-	-	10	35
206	46	-	-	-
250	47	25	20	47

An average Open Wire Unbalance (8" spacing-transposed for 150 kc operation is given in i/E is given below:

Kc	i/E
50	20
90	25
140	40

A typical phantomed open wire line (12" spacing) at 1000 cps had an i/E = 9....A circuit employing the alternate arm transposition scheme had an i/E = 100 at 50 kc.

In general, the apparatus should be balanced to ground $\left(\frac{i}{E}\right)$ to a value of about 1/2 the value of the lines over which it is to operate. In this manner the balance of the lines will not be affected by the apparatus connected to the lines.

Filters

The amount of attenuation needed outside the passbands of various filters depends upon the output power and the frequency assignments.

In bandpass filters used for double sideband transmitted carrier operation interference between the two sidebands due to phase delay distortion can result in beat frequencies.

The utilization of various ferrite cores in filter designs should be approached with caution in order to prevent harmful effects due to core saturation. Line attenuation and levels are also important in preventing this type of difficulty.

VII. Interchannel Crosstalk

Interchannel crosstalk in equipment should be of low order of magnitude compared to the line crosstalk. Crosstalk between channels can be greatest where compandors are employed; 60 db or more of crosstalk loss is desirable.

One manufacturer stated that he plays tape recordings at 0 Vu into all channels but one of his carrier equipment and then listens on this channel to determine the nature and extent of the crosstalk.

Undesired modulation products due to superposed systems can be expressed as a percentage of total noise.

One manufacturer mentioned that his filter design objective to suppress unintelligible crosstalk is 55 db while that for intelligible crosstalk is 65 db.

There was no discussion of frequency selections to minimize effects due to interchannel modulation.

VIII. Compandors

There is a 20-25 db advantage due to compandor usage in reducing most types of interference. It was mentioned that compandors in a more economical price range might be integrated into rural telephone plant.

Compandors are being used on short-haul circuits. On intertoll routes, six-tandomed compandors might be in the circuit. If compandors are added to the end links, the compandor standards must be maintained....Since operation of a compandor is not instantaneous, transmission impairment may result. Compandor tracking is very important.

The use of compandored and non-compandored systems on the same line is not a good practice. Signaling functions do not pass through the compandors. Therefore there is still a possibility of cross signaling on certain systems.

IX. Frequency and Phase Modulation

In a frequency or phase-modulated system, squeals and squawks result rather than crosstalk when there is relatively low crosstalk loss between two adjacent channels....On power lines the crosstalk loss between phases is sometimes as low as 10 db.

Narrow-band FM does not exhibit any capture effect....Phase modulation will give an improvement over FM from the noise standpoint because of pre-emphasis and de-emphasis arrangements.

X. Noise Levels and Signal to Noise Ratios

Noise impairment can be stated in terms of the increased loss of the circuit....The Bell System does not use signal-to-noise ratios....Noise levels greater than 30 dba should not be permitted on trunk circuits.... Noise levels of 55 dba will interfere with the desired signal.

XI. Susceptibility of Pilot Channel Regulations

Pilot channel regulators are susceptible to interference from other frequencies if the regulators are fast-acting and there is a fast-beat frequency present. The regulator will then cause speech to have a wobble.

XII. Nationwide Toll Dialing

Up to eight intertoll links can be used in nationwide toll dialing. Variations in individual circuits must be kept to a minimum....Circuits in this intertoll network must have the lowest possible net losses.... The lowest possible net losses are limited by echo effects.

At the end terminal, 2 db pads can be inserted to take care of the wide range of impedances connected to the end terminals.

Typical long-haul carriers have a bandwidth sufficient to efficiently transmit frequencies up to 3500 cps with in-band signaling of either 1600 or 2000 cps. Short-haul carrier can transmit frequencies up to 3100-3200 cps with out-of-band signaling of 3700 cps.

The bottom of the carrier-derived speech bands must have sufficient response for the transmittal of low frequency tones used in certain signaling arrangements.

A question was raised as to the advantage and disadvantage of "tone-on when idle" and "tone-off when idle" trunk signaling arrangements. It was mentioned that this subject was one of those discussed in the Questions and Answers on Long Range Planning prepared by the USITA Technical Committee and discussed with the Bell System. This paper will be available within ten days of this meeting and can be obtained by writing to the USITA, 411-17 Munsey Building, Washington 4, D. C.

XIII. Interference From Foreign Carrier Or Radio Systems

On the subject of interference from power line carrier systems, the following points were mentioned:

a. These carrier systems are usually crystal controlled.

b. The power companies and telephone companies should interchange information at periodic intervals regarding plans for carrier assignments in any particular area.

Interference to open wire carrier systems from the Navy Radio Station at Jim Creek, Washington, have been noted as far east as Minneapolis, Minnesota.

Interference to cable carrier systems due to interfering signals being picked up by drop wire and open wire taps feeding the cable were discussed. Suppression traps and various slot filter arrangements were used to suppress this form of interference but these expedients increase maintenance costs.

The attenuation effects of hoar-frost are much worse than sleet....Sleet loss can be 5 to 6 times as great as the normal attenuation of the facilities.

Interference to various circuits as a result of precipitation static was briefly discussed....Precipitation static can cause interference to carrier system operation, both to voice and signaling functions.

XIV. Carrier System Applications to Minimize Coordination Problems

It was stressed that system planning becomes extremely important in situations where telephone companies are contemplating the use of both subscriber line and trunk line carrier systems in their plant.

It was suggested that REA try to steer consulting engineers to construct plant in such a manner that conflicting routes are minimized.

The type of transposition schemes that REA is considering for various system designs were discussed briefly. Those mentioned by name were the Exposed Line, Type D and the U. S. Army Transposition Scheme.

One engineer said that he favored taking one pair of wires transposed to a high frequency scheme and loading them with various carrier systems in

order to derive the greatest number of circuits from the minimum of outside plant facilities. It was agreed that this arrangement would probably work well until other wire pairs were added to this lead.

XV. Conclusions and Further Action

As a result of the discussion of all aspects of Carrier Equipment Design and Application, there were numerous comments concerning the value of some means to follow up on the various areas where continued coordination between manufacturers and users is needed.

The REA representatives indicated that they felt that such continued coordination was essential for the maximum future employment of carrier without the need of restrictive regulations. They further indicated that REA borrowers represent only a small percent of carrier users and therefore it did not seem that REA should sponsor an organization for this purpose. They suggested that USITA, NEMA or AIEE might be appropriate sponsors. REA would actively participate in any such group if requested.

Mr. C. H. McLean, Chairman, Radio & Carrier Committee of USITA stated that he believed USITA jointly with manufacturers should continue the activity. He stated that he would bring the suggestion before the USITA Executive Group for their consideration. He was desirous of an expression from the manufacturers on their views.

Mr. Orla Moody, AT & TCo., said that they will cooperate with other interested parties but that they would not initiate any such action.

Several Manufacturers' Representatives commented in favor of some kind of organization and as a result, a short meeting of all representatives from manufacturers was scheduled immediately after adjournment of the regular meeting to discuss the matter and arrange for specific follow-up action.


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Summary of major points discussed at Carrier Coordination Meeting ... held at
Washington, D.C., April 14, 1954
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